Space Weather Technical Forecast

Issued on Wednesday, 12 July 2023 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storm likely, chance of G2/Moderate Storm on 13 July with CME arrival. Chance of R1/R2 radio blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M6.8 flare, peaking at 11/1808 UTC, originating from a newly emerging sunspot region (now numbered AR3372) on the northeast limb. However, due to its location near the northeast limb it is currently difficult to analyse and give it a Mount Wilson classification. Currently, this region appears to consist of a large leader spot (possibly an H group at present), although potentially there is more of this region due to come round the northeast limb. An M5.8 flare originating from AR3363, peaked at 11/2215UTC and produced a R2 Radio Blackout. Awaiting imagery for any potential CME from this event, which given its location, could consist of an Earth-directed component - pending analysis.

There are currently twelve sunspot regions on the visible disc. AR3361 in the northwest is the most magnetically complex region, which contains a delta spot. AR3363 in the southeast is the largest region, and presents as a large unipolar spot. AR3366, AR3368 and AR3369 are all close together in the southwest, with some magnetic interaction between these regions, probably increasing instability. AR3367 in the northwest is moderately large and continues to display reorganisation of the intermediate spots with little change in overall size and complexity. There are two new and currently unnumbered sunspot regions in the southeast, although these appear small and stable. The majority of the remaining regions appear small and simple.

A partial halo CME associated with the 10 July M2 flare was seen travelling towards the southwest in coronagraph imagery and an Earth-directed component is considered probable as detailed below.

A filament eruption, which lifted off around 11/1900UTC, near AR3363, produced a CME in coronagraph imagery, with the bulk of the material appearing to be heading southwards. This is yet to be analysed for any potential Earth-directed component – pending analysis.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1 by ACE/DSCOVR, was at slow-ambient levels throughout and solar winds varied between 320-360 km/s. The density was below average to average. Total magnetic field strength has been weak to moderate throughout, between 3 nT and rising to 9 nT by end of period, whilst the north-south component varied weakly. The phi angle has been predominately positive (away from the Sun). Geomagnetic activity has been at Quiet levels throughout (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, has been well below the S1/Minor Storm level, but is very slightly raised above the normal background as a result of recent M-class flares. High energy electron flux (greater than 2MeV), as observed by GOES16, was at mostly moderate levels, with a peak of 846 pfu at 11/1555 UTC. The 24-hour integrated fluence was below the Active (1e8 integrated pfu) threshold on a steady trend. A fluence of 1.96e7 pfu was recorded at 12/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is most likely through the guidance period, with a slight chance of an isolated X-class flare.

Solar Wind / Geomagnetic Activity: A partial halo CME associated with the M2 flare on the 10th July was seen travelling towards the southwest in coronagraph imagery. An Earth directed shock component is considered probable. At this stage, an arrival time of around 13/0600 UTC is most likely, but confidence is rather low.

The solar wind is currently slow-ambient and is likely to remain that way until the CME arrival. As the CME effects continue, a HSS from CH23/- is likely to arrive during Day 2 (13 July). The combination of CME effects and HSS could lead to increased geomagnetic impacts.
Geomagnetic activity is forecast to be Quiet at first, becoming Active to G1/Minor Storm (Kp4-5) with a chance of G2/Moderate Storm intervals (Kp6) due to CME and HSS effects on Day 2 (13 July), then probably returning to Unsettled (Kp3) by Days 3 and 4 (14-15 July).

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight chance of reaching the S1/Minor Storm threshold through the period, should any larger flares occur. High energy electron flux (greater than 2MeV) is likely to reach moderate levels at first, with a sharp decline anticipated during Day 2 (13 July) as the anticipated CME arrives. Electron fluence is expected to remain below the Active threshold (1e8 integrated pfu), before dropping during Days 3-4 with the CME and HSS arrivals.

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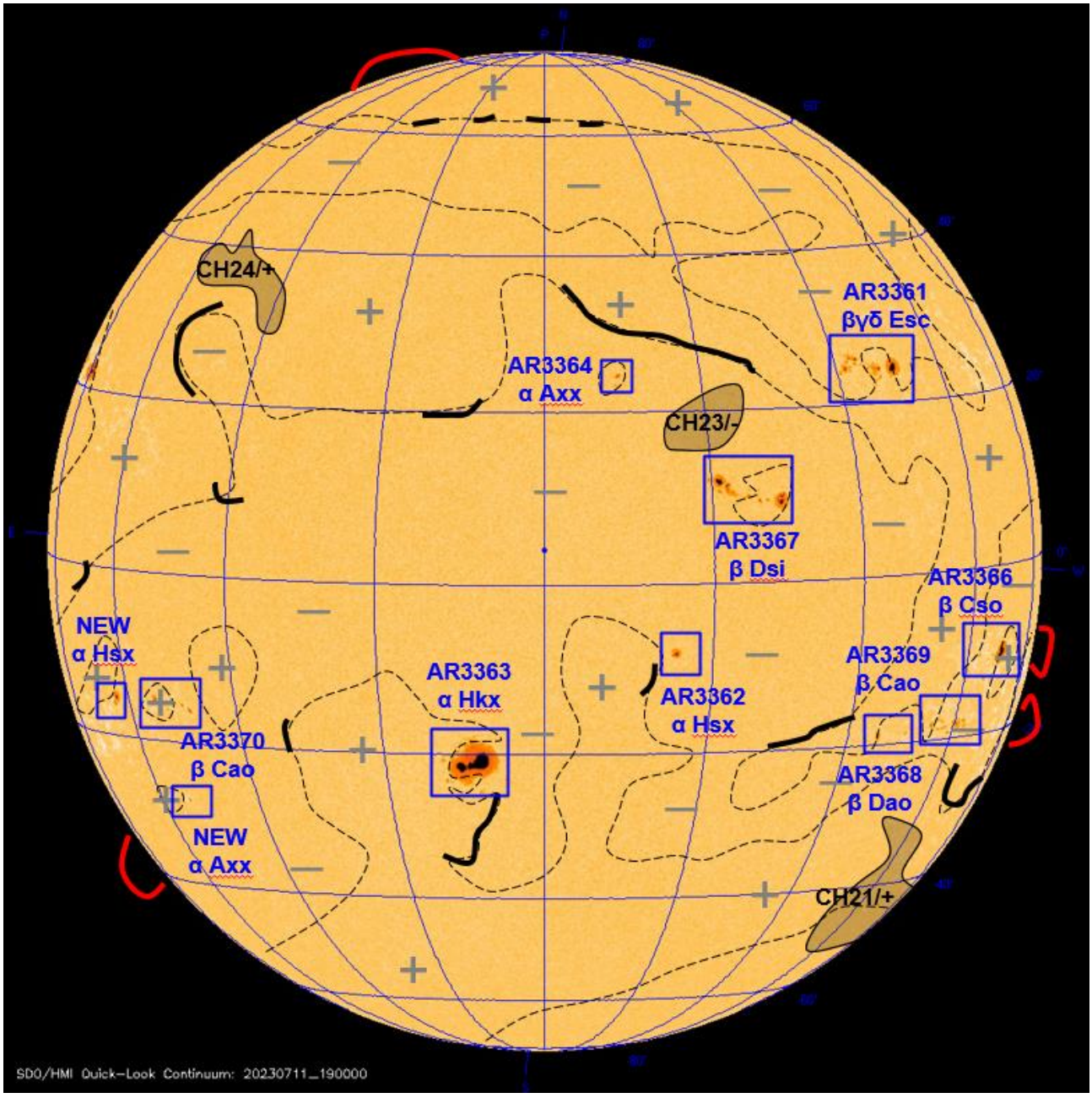
Figure 1. Solar Analysis Valid 11/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A partial halo CME associated with the M2 flare early on 10 July was seen travelling towards the southwest in coronagraph imagery. There was also a fainter asymmetric full halo from the shock. Although the bulk of the CME is expected to pass ahead of Earth, an Earth directed shock component is considered probable. At this stage, an arrival time of around 13/0600 UTC is most likely, but confidence is rather low.

The solar wind is slow-ambient and is likely to remain that way until the CME arrival. As the CME effects continue, a HSS from CH23/- is likely to arrive during Day 2 (13 July). On the previous rotation this feature resulted in solar winds reaching 600-700 km/s, and a maximum geomagnetic response of G2/Moderate storm. On this rotation the feature appears smaller and more fragmented in appearance, and this will probably lead to lower solar wind levels and associated impacts. However, the combination of CME effects and HSS could lead to increased geomagnetic impacts.

Geomagnetic activity is forecast to be Quiet (Kp 0-2) at first, becoming Active to G1/Minor Storm (Kp 4-5) with a small chance of G2/Moderate Storm intervals (Kp 6) due to CME and HSS effects on Day 2 (13 July). Thereafter a decrease in activity is most probable with geomagnetic activity returning to Unsettled levels (Kp 3) on Days 3 and 4 (14-15 July).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	30	20	5
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
10/1107	Partial Halo	AR3366	SW	900 km/s	13/0600 UTC	Limited shock expected. Rather low confidence for CME arrival

Figure 2: MOSWOC Enlil (top) and Ensemble (Bottom) showing potential arrival times for CME on 13 July.

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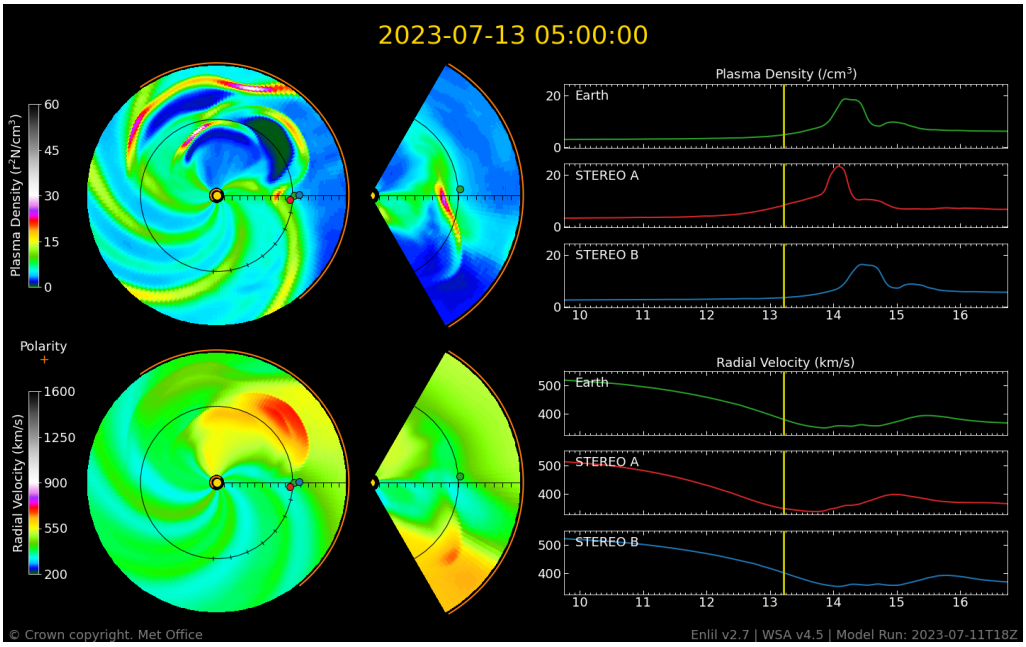

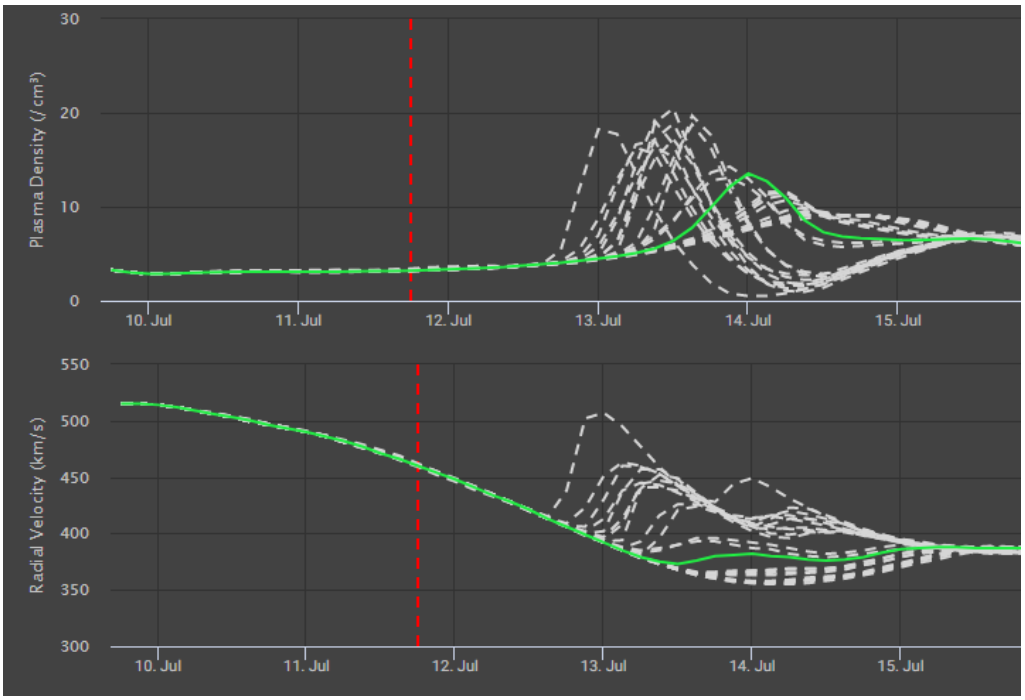

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Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate, with a M6.8 flare peaking at 11/1808 UTC, originating from a new and currently unnumbered sunspot region on the northeast limb. This region is currently difficult to analyse due to foreshortening effect. Only the large leader spot is currently visible on imagery, with SDO HMI magnetogram suggesting this region could be quite magnetically complex, with more of this region due to rotate onto the Earth-facing disc in the coming days. A better analysis of this region will be made once it comes into full view. Low to moderate activity is likely to continue, with a slight chance of an isolated X-class flare.

An M5.8 flare originating from AR3363 in the southeast, peaking at 11/2215UTC produced a R2 Radio Blackout. Awaiting imagery for any potential CME from this event.

There are currently twelve sunspot regions on the visible disc. AR3361 in the northwest is the most magnetically complex region, with a delta spot. AR3363 in the southeast is the largest region, and presents as a large unipolar spot. AR3366, AR3368 and AR3369 are all close together in the southwest, with some magnetic interaction between these regions, probably increasing instability. AR3367 in the northwest is moderately large and continues to display reorganisation of the intermediate spots with little change in overall size and complexity. Two new and unnumbered regions have emerged in the southeast limb, these appear to be unipolar and simple.

No major active region is forecast to depart the visible disc during the period and far side sounding data suggests that further regions may rotate onto the disc during the coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

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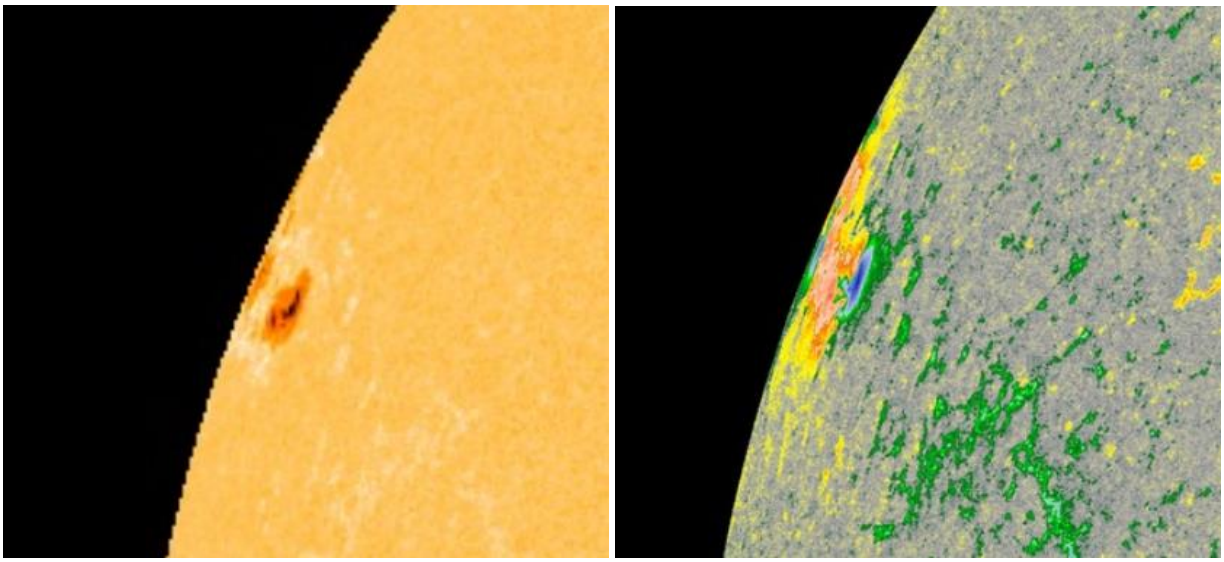
Figure 3: SDO/HMI intensity gram (left) and Magnetogram (right) shows AR3372 close to the NE limb, which produced the recent M6.8 flare (*see* SDO AIA 94 image below).



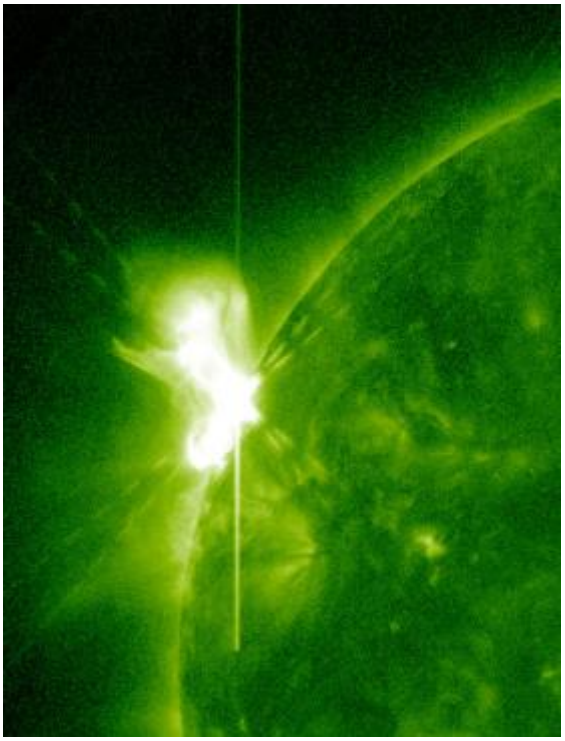


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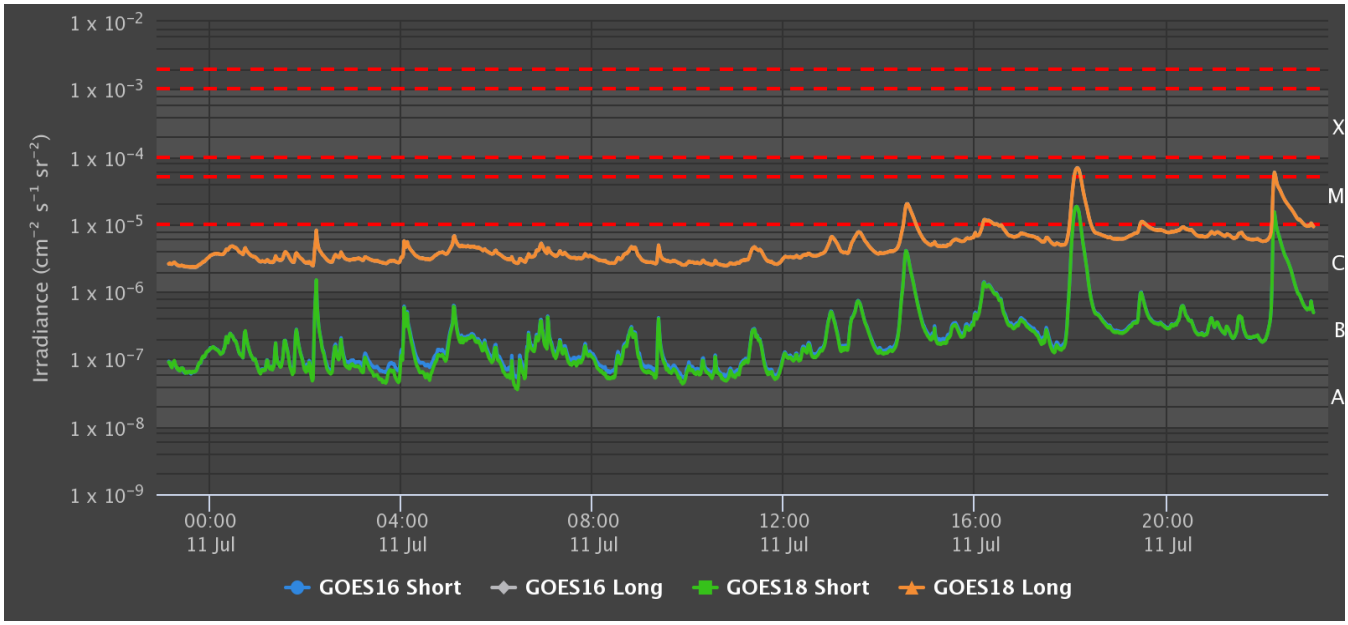
Figure 4: GOES X-Ray flares



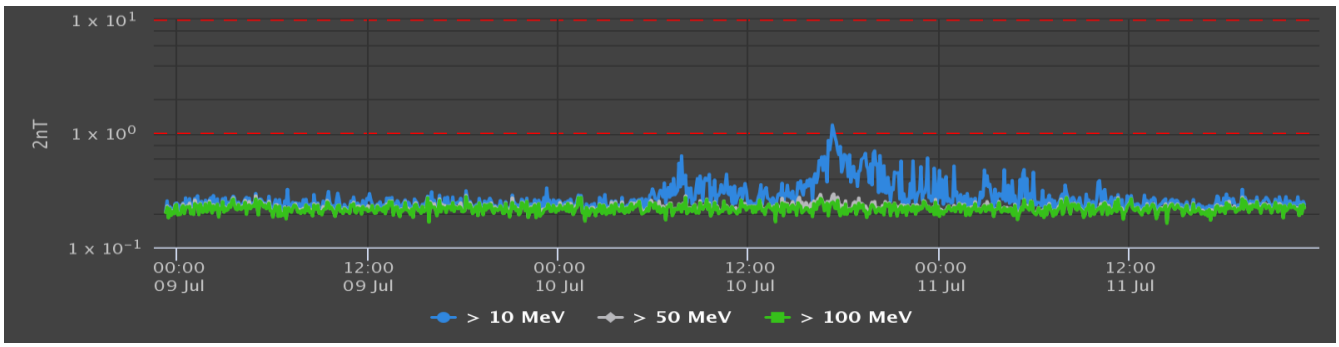
Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently near background levels, although recently very slightly raised in the wake of the recent M-flare early on 10 July. There is a slight chance of S1/Minor or greater storm levels being reached through this period, should any larger flares occur mainly from regions in the western hemisphere, and perhaps most likely from AR3366 which appears to be more favourable for this activity.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 5: GOES-16 Proton Flux over the past 3 days



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GEO has been at largely moderate levels in recent days. The BAS radiation belt model suggests only a limited increase in electron flux has taken place below GEO, probably due to a recent HSS. Electron flux is now considered most likely to continue to reach moderate levels over the next couple of days. The expected arrival of a CME on Day 2 (13 July), soon followed or accompanied by a HSS is expected to give a sharp decrease in flux during the second half of the period.

Electron fluence continues to remain on a broadly level trend below Active levels (1e8 integrated pfu). This is likely to remain similar, perhaps with a further slight rise possible through Day 1 (12 July), before a drop off from Day 2 (13 July) as the CME and HSS arrive. MOSWOC REFM guidance is showing a steady trend below Active, which is considered to be giving sensible guidance although it won't be taking account of the likely CME arrival.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	10	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 6: REFM electron fluence

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